Relationships between bird communities and vegetation structure in Honghua'erji, northern Inner Mongolia

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Abstract: The survey on bird communities was conducted by the belt-style method in six different sample plots in the Honghua'erji Forests area in the northern Inner Mongolia in June 2001 and totally 28 bird species were recorded. Vegetation investigation was carried out in five 10 m×10 m quadrats at each plot. The asymptotic regression function formulae were adopted to identify the relationships between the vegetation coverage and the numbers of bird species and individuals. The analytical results showed that the changes of species number and density of bird as well as the formation of bird communities follow the changes of forest type and the total foliage. Both the number of bird species and their density decreased with the decrease of total foliage. The similarity of bird community was very low at the breeding time. In the same classification of cluster, no similarity was higher than 0.65, which indicated that the composition of species had a great difference between all the bird communities. The bird breeding density was closely related to forest growth stage. From the bare grassland ecosystem to climax ecosystem, the density of bird species showed a gradually increasing trend.

Key words: Bird community, Vegetation structure, Honghua'erji, Northern Inner Mongolia
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Introduction

Birds take high position in ecosystem. It is important for both composition of food chains of ecosystem and the change of species of the ecological environment. The major tree species are *Pinus sylvestris* var.*mongolica* in the Honghua'erji Forest Agency in northern Inner Mongolia. Sandy soil pine trees of this area are located in the transitional belt between forest and grassland, which forms the forest-grassland ecosystem in Hulunbeir grassland.

The influence of forest flora on the avifauna had been studied in Japan (Higuchi *et al* 1982; Fujimaki 1981; Kanai *et al* 1996; Maeda 1998) and USA (Macarthur and Macarthur 1961; Verner and Larson1989). The grassland bird community and structure of the forest bird community in summer were studied in the northern Daxing'an Mountains (Shi *et al.* 1999; Gao *et al.* 1984). However the fauna of this region were seldom studied in the Honghua'erji Forest Agency in northern Inner Mongolia, and the detailed information of summer bird communities in the northern Inner Mongolia and the descriptions on the diversity of bird community is seldom reported. This paper mainly studied the relationships between bird communities and vegetation structure.

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Study area

The study area is located in the Honghua'erji Forest Agency area (119°56′ to 120°03′ E; 48°06′ to 48°13′ N) in the northern Inner Mongolia, with an elevation of 743-921 m. The general slope of sand land is 0-5° and mountain slope is 10-15°. Annual average temperature is 5.3°C. July is the hottest month of a year, with an average temperature of 19.5°C, and the coldest month is January, with an average temperature of -33.0°C. The extreme highest atmospheric temperature is 41.3°C and the extreme lowest is -49.5°C. Frost comes in early September and end in the middle of May, with a frostless period of 150 days. Annual daylight time averages 2 800 h. The annual rainfall is 266.1-675.0 mm, mainly concentrating in July and September. Snow season lasts about 150 days. In wood areas of the shaded slope or the area with higher elevation, snow layer is as thick as 60-70 cm in depth.

The plant species in *Pinus sylvestris* var.*mongolica* forest is Dawulia Mongolia flora. Shrubs are seldom seen in this area, except for a few living shrub or half-shrub such as *Artemisia frigide*, *Thymus serpyllum* etc., which occasionally grow in arid land or semiarid land, and some *Calaqua microphylla* plants scattered living at the top of hill. *Pinus sylvestris* var.*mongolica* is the main forest species of this area. The herbs are distributed mainly in the gaps of woodland and forest edge, and form the meadow-grassland community, which is mainly composed of *Stipa baicalensis, Festuca ovina, Arex pediformis, Hermerocallis Keiskei, Sangusiorba officinalis, Soposhnikovia davuricuta, Iris dichotoma, Pulsatilla turczaninuvii, Bupleu-*

rum Spp., *Polygomatum humile, Potentilla fragarioides* etc.. The main plant species of between the sand dune and low-lying land are *Rosa davurica, Malus baccata,* and some mesial bushes. Some places possess small dump white birch and poplar (Synthetic Investigation Group of Chinese Academy of Science 1985; Shi *et al* 1998,1999; Han 1999).

Methods

The survey on bird communities was separately conducted in six different sample plots in the Honghua'erji Forests area in the northern Inner Mongolia. Firstly a start point was randomly chosen and marked with adhesive tape, after then two 50-m lines in opposite directions from the start point were assigned in random direction, and another 50 m line (middle axis line) was assigned from the start point but perpendicular to the former two lines. The end point of the vertical line is taken as the start point of a second selection. Two lines in opposite directions from the start point should be parallel to those in the first selection. By this means, a belt including 10 selections was drawn. Thus a belt of 500 m (Sample A is 400 m) was made.

When counting birds, three observers slowly walked at the same time in a parallel line with 25 m intervals along the middle axis line and mark the species, number, time and site of sighted birds on a map. Bird counting for each site was repeated five times at an interval of 20 min. Each counting lasted for 20-30 min.

Five 10 m×10 m quadrats were set up in all study plots for measuring DBH, height of trees, and coverage of vegetation. The heights of thetop-layer, sublayer and low-layer of stand as well as the grass layer were recorded respectively. Vegetation coverage of each layer in each quadrat was visually estimated as percentage of coverage of the specific layer and a general coverage of each quadrat was added up with the data of each layer (Appendix 2). All investigations were conducted at time from 05:00 to 16:00 in June 2001.

The curves of the asymptotic regression function formulae were adopted to identify the relationships between the vegetation coverage and the numbers of bird species and individuals. Regression coefficients were calculated with the avifauna parameters and the vegetation parameters. The correlation coefficients for these relationships were statistically tested at $p<0.05$, differences in number of species and density of birds between total foliage (TF) were statistically examined at the $p<0.05$ levels.

Results

A total of twenty-eight species of birds were recorded (Appendix 1). Of which, twenty-four species belong to Passeriformes, two species to Cuculiformes, one species to Nightjariformes, and one species to Falconiformes. The most common species is Oriental Tree Pipit (*Anthus hodgsoni)* (we could see it at every site), followed by Arctic Willow Warbler (*Phylloscopus borealis)* and Thick-billed willow Warbler *(Phylloscopus schwarzi).* The other species were sighted sporadically or temporarily at a few sites, frequently in small numbers.

In woodland, both the number of bird species and their density decreased with the decrease of total foliage (Fig.1 and Fig.2) (regression analyses n= 5, $P<0.05$); the highest values were 0.56 species/hm^2 and 6.28 birds/hm^2 at the site C, while the lowest were 0.10 species/hm^2 and 1.05 birds/hm^2 at the site A (see Table 1).

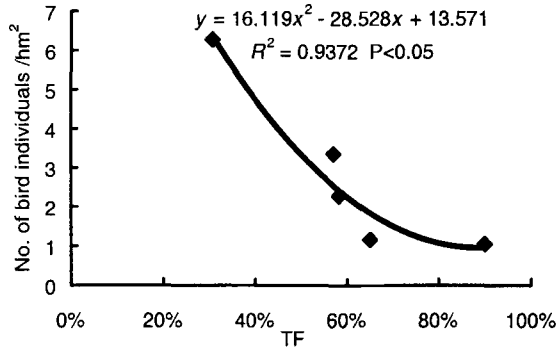

Fig.1 Relationship between the individual number of bird per hectare and total foliage (TF)

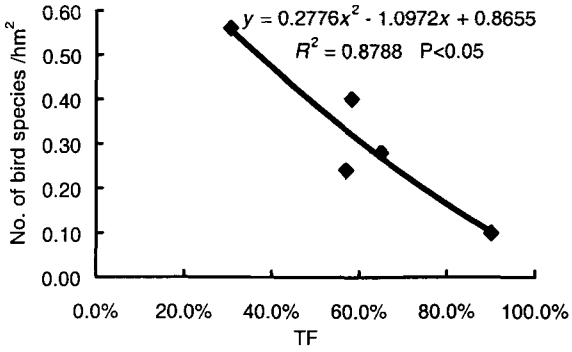

Fig.2 Relationship between the species number of bird and total foliage (TF)

Table 1. Numbers of bird species and individual per hectare

Site No.	No. of bird species/hm^2	No. of bird individuals/hm^2
A	0.10	1.05
B	0.40	2.28
C	0.56	6.28
D	0.28	1.16
E	0.24	3.36
F	0.13	3.87

The similarity of bird communities of the survey areas was obtained by using coefficient of community of Jaccard. We analyzed it by similarity matrix and clustering method (See Table 2 and Fig.3).

In Inner Mongolia, the similarity of bird community was very low at the breeding time. In the same classification of

cluster, no similarity is bigger than 0.65. It suggests that the composition of species has a great difference between all the bird communities.

Table 2. Similarity of bird communities of the survey area

	A	B	C	D	E	F
A	1					
B	0.2	1				
C	0.14	0.6	1			
D	0.13	0.31	0.24	1		
E	0.14	0.33	0.33	0.44	1	
F	0.07	0.21	0.17	0.18	0.19	1

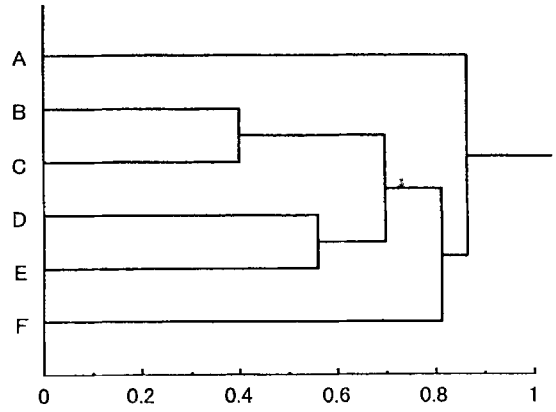

Fig. 3 Dendrogram showing no similarities between the bird communities of the six sites.

Discussion

Fewer reports were published on the interrelation of the bird communities, total foliage, and the consequent vegetation changes related to forest ecosystem in the northern Inner Mongolia. Our study on vegetation and total foliage indicated that the changes of species number and density of bird as well as the formation of bird communities follow the changes of forest type and the total foliage. This is possibility due to a habitat preference of each bird species and human disturbance to the forest ecosystem.

Oriental Tree Pipit (*Anthus hodgsoni*), Arctic Willow Warbler (*Phylloscopus borealis*), Common Rosefinch (*Carpodacus erythrinus*), Common Cuckcoo (*Cuculus canorus*) appeared in the village areas, because of some trees around the village, but they did not nest there. The case is similar to some previous studies (Gao and Xiang 1984; Kurosawa and Askins 1999; Woodward *et al.* 2001). The feeding sites of these species are probably not restricted to the forest. Otherwise village birds have not been sighted in the forest areas. The reason is that the investigation forest is far away from the village. In general, village birds seldom appear in the forest farther than 1.5 km away (Shi *et al.* 1999). Since 1960s, the settlement program for nomadic people was carried out, bird community of village surely appeared (Maruyama *et al.* 1996).

Many researchers have noticed the relationship of bird communities and different development stages of vegetation (Nakamura 1967,1975; Kuroda 1974; Yui 1976, 1977, 1983; Fujimaki 1981; Higuchi, *et al.* 1982). Generally, the birds breeding density is closely related to forest growth stage. From the bare grassland ecosystem to climax ecosystem, the density of bird species gradually increased, yet, the higher the crown density of young tree was, the smaller the bird numbers were. (Yui 1983; Fujimaki 1981; Zhou 1987; Woodward *et al.* 2001). Our study gained similar results to the above. For example, the crown density of broad-leaved forest at the hilltop is higher, yet the bird species are fewer. In addition, a wildfire happened in the Hulunbei'er Honghuaerji Forest Agency in 1996 brought great influence on the forest growth, distribution, and pattern, and the structure of bird community also had a great change. The bird community structure was affected by many factors, such as vegetation, the size and structure of forest, and forest type. The frequent wildfire, especially in young tree areas, caused the bird community structure to be fragile and unstable.

Different vegetation types provide different habitat conditions to birds, and the structure of bird community differs with the habitat conditions. Thus the further studies on the relationship of habitat and bird community is of great importance not only for ecological theory, but also for scientific management of forest and environmental preservation.

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Appendix 1. Rate of bird species observed at the 6 sites, northern Inner Mongolia, June 2001

Bird species	Site A	Site B	Site C	Site D	Site E	Site F
	Broad leaved forest	Pine	Pine and broadleaved trees edge	Pine plantation	Grass & open forest of Pine	Village and forest edge
1.Oriental Tree Pipit	0.6667	0.2632	0.0637	0.3103	0.3452	0.0084
2.Willow Tit	0.3333	0.0175	0.0127	—	—	—
3. Arctic Willow Warbler	—	0.4912	0.0064	0.2759	0.0595	0.0056
4.Common Cuckcoo	—	0.0175	0.0191	0.0345	0.0119	0.0391
5.Thickbilled willow Warbler	—	0.0351	0.0255	0.0345	0.0119	—
6.Greenfinch	—	0.0175	0.0509	—	—	0.0363
7.Carrion Crow	—	0.0351	0.0127	—	—	—
8.Jay	—	0.0175	0.0127	—	—	—
9.Grey Wagtail	—	0.0351	0.0064	—	—	—
10.Red Crossbill	—	—	0.5732	—	0.1786	—
11.Pine Bunting	—	—	0.1274	—	—	—
12.Meadow Bunting	—	—	0.0446	—	—	—
13.Red-tailed Shrike	—	—	0.0318	—	—	—
14.Common Rosefinch	—	—	0.0127	—	—	—
15. Tristram's Bunting	—	—	—	0.2069	—	—
16. Coal Tit	—	—	—	0.1034	—	—
17. Oriental Cuckoo	—	—	—	0.0345	—	—
18. House sparrow	—	—	—	—	—	0.6369
19.Tree sparrow	—	—	—	—	—	0.0950
20.House Swallow	—	—	—	—	—	0.0838
21.Golden-rumped Swallow	—	—	—	—	—	0.0559
22.White Wagtail	—	—	—	—	—	0.0223
23.Great tit	—	—	—	—	—	0.0056
24.Paddy-field pipit	—	—	—	—	—	0.0056
25.thick-billed crow	—	—	—	—	—	0.0028
26.Black kite	—	—	—	—	—	0.0028
27.Skylark	—	—	—	—	0.3929	—
28.Jungle Nightjar	—	0.0702	—	—	—	—

Appendix 2. Vegetation structure observed at the 6 sites, northern Inner Mongolia, June 2001

Site	Vegetation	Height	DBH	Coverage	Dominance	Spot
A	High timber layer	9.03±0.32	5.33±0.44	41.25%	Poplar	119°59′ 37"E;48°14′ 52"N
	Sub-high timber layer	4.29±0.31	1.97±0.24	13.75%	Birch	
	Low timber layer	±				
	Glass layer			27.50%		
	Total foliage			90.00%		
B	High timber layer	11.97±0.52	12.68±1.09	32.50%	pines	119°59′ 26"E;48°15′ 23"N
	Sub-high timber layer			±	Poplar	
	Low timber layer			7%±	pines	
	Glass layer			18.75%		
	Total foliage			58.25%		
C	High timber layer	10-15		5.00%	pines	120°01′ 58"E;48°25′ 07"N
	Sub-high timber layer			±	pines	
	Low timber layer			±	Rose	
	Glass layer			25.50%		
	Total foliage			30.50%		
D	High timber layer	11.85±0.19	12.82±0.45	40%±	pines	119°58′ 15"E;48°13′ 24"8N
	Sub-high timber layer	3.5±0.74	1.93±0.36	5%-	pines	
	Low timber layer			±		
	Glass layer			20%		
	Total foliage			65%		
E	High timber layer	3.46±0.49	3.84±0.86	5%	pines	119°52′ 26.5"E;48°13′ 41.8"N
	Sub-high timber layer			±		
	Low timber layer			±		
	Glass layer			52%		
	Total foliage			57%		
F (Village)	High timber layer			5%	pines	119°27′ 55.8"E;47°50′ 52.0"N
	Sub-high timber layer			±		
	Low timber layer			5%	Willow	
	Glass layer			10%	Grass, farm	
	Total foliage			20%		